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THE HUMAN TRYPANOSOMIASIS OF NYASALAND.

BY

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I.—HISTORICAL.

In view of the fact that *Glossina palpalis* does not occur in the Protectorate it was hoped that there was no danger of trypanosomiasis becoming endemic, and until recently such cases as were diagnosed were thought to have been imported from North-eastern Rhodesia, though in June, 1910, Dr. H. S. STANNUS[1] pointed out that in two of the cases the history suggested that infection had been contracted in the Protectorate, and postulated *G. fusca* (*brevipalpis* NEWST.), as the infecting agent.

The first case was found in the West Nyasa district by Dr. J. B. DAVEY, in October, 1908, whereupon investigations on a large scale were instituted, Drs. STANNUS and DAVEY being detailed to the northern districts, and the late Capt. HARDY, R.A.M.C., to those on the south-west shores of Lake Nyasa. These investigations were very thoroughly carried out and altogether some 60,000 natives were examined by gland palpation, blood-smears being made from sick persons. No cases were, however, found by this means.

In December of the same year Capt. HARDY was found to be infected, and it was said that in some way he must have inoculated himself from the patient under his charge; there was, however, not the slightest evidence to support this assumption. Latterly it has been suggested that he may have contracted the disease in the Congo, and was responsible for its introduction into this country. Personally, I am inclined to agree with the opinion of the ill-fated officer himself, who believed that he had become infected while investigating in the plains bordering Lake Nyasa.

During 1909 three further cases were diagnosed, one at the mission hospital at Kota-Kota, and the others in that at Blantyre; and in June, 1910, another at the Government hospital in Zomba.

At this time (1910) the writer was the only officer detailed for investigation work, and when, in August of that year, two cases were found in the mission hospital at Kasungu, near the Rhodesian border, and a third at the Mvera mission hospital in the Dowa district, he was recalled from North Nyasa to re-establish the segregation camp at Dowa, and to investigate in that district.

Shortly after arrival a European of the Dutch mission was seen and was found to be heavily infected with trypanosomiasis. From the history it was evident that the patient had become infected while shooting in the neighbourhood. This was the first certain intimation that previous cases had not necessarily been imported.

Investigations were immediately commenced, and during September, six cases were found in that part of the Dowa district near the lake. At the same time reports were received of a heavy death-rate in some villages, due to some disease not known to the natives, but which was suggestive of trypanosomiasis.

During the following fifteen months a total of 47 cases have been diagnosed from the same locality, exclusive of those who were regarded with suspicion, but in whom no diagnosis was made before death supervened.

A temporary camp was built at Mvera mission under the charge of Dr. W. A. MURRAY, to which cases were sent as found. A permanent camp has since been built on Ng'ani Hill, to which the patients were transferred in May, 1911.

II.—METHODS OF INVESTIGATION.

When investigations were first commenced the following procedure was adopted:—Warning was sent to the headman of the village to be visited that all his people were required to be present for examination, and on arrival at the village the inhabitants were palpated for enlarged glands, any sick persons being examined. It was soon found, however, that only a percentage of the population was seen, and that the sick were least likely to be produced. A native capitao was then sent on ahead with instructions to find out if there were any sick in the village to be visited, and no warning was given of my approach. The natives had thus no time to remove their sick and a rigorous house-to-house search brought them to light. By these means the first cases were discovered. It was found that a large percentage of healthy natives had palpable glands in no way different from those of the infected persons, so that this method of choosing subjects for examination—gland palpation—was discontinued.

In view of the obstructive tactics adopted by the natives, I recommended in my first report that a census of this part of the district be made, and the scattered isolated communities concentrated into large villages. This was approved, and a special magistrate, Mr. A. H. WYATT, was detailed for the duty. The census was ready for use in January, 1911, and has been found to be of great assistance, though very careful and continuous correction is necessary to keep it up to date, as its efficiency is dependent on absolute accuracy. Its moral effect on the natives, in assisting control, is not the least of its uses. A system of passes is a necessary adjunct to the census, and it is indispensable that it be scrupulously carried out.

Certain isolated villages which reported a heavy death-rate were removed to the hills, but no extensive scheme of depopulation was attempted. No villages were, however, left within the fly-belt proper.

A number of native capitaos were then taught how to make thick and thin blood-smears, and were detailed each to his own area, to patrol it regularly, and to report all cases of sickness and deaths. These patrols also take blood-smears from every sick person, without discrimination, and send them to head-quarters for examination. Accurate information is thus obtained as to the extent and severity of the endemic, and

numerous cases have been found by these means; such cases are, however, almost invariably in an advanced stage, and not infrequently die before admission into camp.

Every village is visited in person as often as possible, the roll called, and every man, woman and child inspected. Fresh coverslip preparations are made from every person who looks ill, or who has previously been reported as having been ill; any native having symptoms regarded as suspicious is kept under observation till a diagnosis is made.

III.—EPIDEMIOLOGY.

It would seem that more natives become infected during the rains (November to March), and the weeks immediately preceding their breaking, than during the dry season. This may be explained by the fact that the natives commence working in their gardens in October, and as this necessitates clearing the bush, they would be more exposed to the bites of fly during these months than at any other time of the year. On the other hand the infected area is more or less flooded during the rains, and this, by lowering their resistance, may render the inhabitants more liable to infection, or, after infection, may accelerate the course of the disease. Certainly a larger number of deaths has occurred from all causes during these months.

It is of interest to note that of the 47 cases diagnosed in this locality, 25 or 53·2 per cent. were men, 18 or 38·3 per cent. were women, and 4 or 8·5 per cent. were boys. No girls have been found to be infected. It may be mentioned in this connection that among the natives, the men do all the work of clearing the bush in making a new garden, both sexes doing the hoeing, while the women alone are concerned in the fetching and carrying of water, firewood, etc.

In view of the fact that all cases found were either living in country infested with *G. morsitans*, or were proved to have recently visited such country, and, further, that the number of infected persons and of deaths in any village was directly proportionate to the amount of fly in the immediate neighbourhood, it has been assumed for the purposes of administration that this species is the definitive host of the disease. Recent researches by TAUTE[2] in Tanganyika, and by KINGHORN[3] in Rhodesia, tend to show that this assumption is correct. Considerable work, however, yet remains to be done, and though everything indicates

that *G. morsitans* is the vector, it is still possible that other arthropods may also be implicated.

As already mentioned, it was suggested by STANNUS[1] that *G. brevipalpis* might be the vector, and it is not improbable that this species will be found to be capable of acting as such, but in view of its scarcity and of its retiring habits it can be only of secondary importance.

The population of the proclaimed area (*i.e.*, over 6 years of age) is 15,426, and of these ·3 per cent. have during the past 15 months been proved to have died from trypanosomiasis. This area, however, includes many villages situated some miles from the fly-belt. The villages in and near the area regarded as the endemic centre have a total of 2,932 adult inhabitants, and of these 1·26 per cent. have been diagnosed as infected. A few villages situated on the border of the fly-belt show an adult death-rate varying from 100 to 150 per 1,000, and 41·6 per cent. of these deaths are known to have been due to this disease, while a further 19 per cent. were regarded as suspicious. The villages removed from the area in 1910, which reported a still heavier death-rate, are not included in these figures.*

It is evident from the above figures that the epidemic is confined to a somewhat limited area as far as this district in concerned, though, as by far the greater proportion of the extensive areas infested by *G. morsitans* remains to be investigated, nothing is yet known as to the extent of trypanosomiasis in the Protectorate as a whole.

It yet remains to be seen whether the slight mortality evidenced by the statistics quoted above can be regarded as due to recent importation of the disease. It is possible that such sporadic infections are rather evidence that *G. morsitans* is the definite host of the disease, as the migratory habits of this fly would result in an infected area, as contrasted with an infected spot where *G. palpalis* is concerned.

Moreover, it is now known that only a small percentage of *G. palpalis* is capable of transmitting trypanosomiasis, and it is a fair assumption that the same holds good for *morsitans*. Postulating *G. morsitans* as the vector, then, it is probable that no such rapid annihilation of communities as occurred in Uganda, for instance, will result here.

The natives do not differentiate trypanosomiasis from other wasting diseases, and seeing that the greater part of the investigation work

* See also Tables, pages 314, 315 and 316.

carried out in previous years was done in areas not infested by *G. morsitans*, it is not impossible that the disease has existed in the Protectorate for years unsuspected. The area now known to be infected must be kept under observation for some years, and investigations extended to all parts of the Protectorate where *morsitans* occurs, before there are sufficient data to warrant any assumption that trypanosomiasis is necessarily of recent introduction.

IV.—ÆTIOLOGY.

The trypanosome is morphologically indistinguishable from *T. gambiense*; dimorphism is marked. STANNUS[4] has obtained by sub-inoculation, trypanosomes resembling the *T. rhodesiense* of STEPHENS and FANTHAM, in that the macronucleus was posterior to (*i.e.*, nearer to the non-flagellar end than) the micronucleus, and considering the similarity of conditions in North-eastern Rhodesia, and the proximity of that country,* it may be regarded as certain that the parasite is the same.

The parasite is further differentiated from *T. gambiense* by the numbers in which it may occur in the peripheral circulation. In the slide taken from Mr. R., from which the diagnosis was made, as many as 10 trypanosomes were counted in a single field (1/12 obj.), and of one of the Rhodesian cases, also a European, it is said, "Trypanosomes were present in considerable numbers, up to 8 to 10 per field."[5]

The numbers vary a great deal in natives, but in no case have they been found in such numbers as in these Europeans. Comparison is, however, difficult, as native cases are rarely seen in the early stages.

V.—INCUBATION PERIOD.

In only one native case has it been possible to obtain any information as to the date of infection, even approximately. In this instance the patient left a village on the lake-shore to visit an infected locality, and was taken ill three weeks after her arrival, giving a maximum period of incubation of twenty-one days.

On the other hand there have been three infections of Europeans in whom the history was more definite. The first of these, Mr. R., was noticed to be unwell—"quiet and not himself"—four days after having

* The Rhodesian fly-belt extends into Nyasaland and in one locality is separated from the lake-shore belt of that Protectorate by only about 12 to 15 miles. (See Map II.)

been severely bitten by tsetse; three days later his temperature was found to be 102·5°. Another case, infected in North-eastern Rhodesia, had a severe chill—the initial symptom—about a fortnight after having been bitten by the fly. In the third instance the initial fever seems to have been developed some seven days after the probable date of infection, though as in the first mentioned case, the patient seemed to feel ill some two or three days earlier.[6] It may be said, then, that the incubation period in Europeans is from seven to fourteen days; possibly it is rather longer in natives, but more evidence is required.

VI.—DURATION.

The total duration of the disease from infection to death is difficult to ascertain owing to the impossibility of getting reliable information from natives. At the outset, however, it was evident that the course of the disease was much more rapid than is usual in sleeping sickness. In one instance a native left his home in the hills to visit a relative in an infected village, and was taken ill soon after his arrival. He was dead (of trypanosomiasis) in less than four months. There was no evidence of any intercurrent disease. In this case the date of infection was ascertained by comparison with other events of known date. No treatment had been given.

On the other hand one case was under treatment at the camp for nine months, and died a month after its cessation. The history showed that she had been infected some two or three months before admission, giving a total duration of at least twelve months.

Three cases in which it is difficult to doubt the diagnosis have apparently recovered. One of these has now been under observation for fifteen months, another for thirteen months, and the third seven months. The first two were under treatment for a time, the last has had none. The first case found in the Protectorate in 1908, also, is alive and has apparently recovered.

VII.—SYMPTOMS.

(1) *The initial fever.*—Few details are available, save in the European cases. In each of these there was considerable local reaction caused by *G. morsitans*—presumably the infecting agent—in each instance in the sub-occipital region. In one case, Mr. R., it was

described to me by a companion of the patient as a "lump about the size of a shilling, rather light in colour, and surrounded by a dark purple ring." Pain at the site was complained of two days after he had been bitten by tsetse,—undoubtedly *G. morsitans*—and the lump was first noticed four days later. When seen fourteen days after the exposure to the fly, there was considerable œdema of the face and neck, but no trace of the lump remained.

In the second instance, Dr. G., infected in North-eastern Rhodesia, "a bite (by *morsitans*) received in the neck became greatly inflamed, and subsequently a black scab $\frac{3}{4}$ in. in diameter formed at this site."[7]

The third patient, Mr. F., complained of pain in the neck, "and his native servants noticed three swellings on the side of his face, and one on the back of the neck, apparently due to insect bites."[7]

In natives, a history of a similar reaction was obtained in two instances, both cases of Dr. PRENTICE, of the Kasungu mission, but no similar history has been elicited from any of the natives infected in the Dowa district, though this has little significance.

It has been said that such local reaction to the bite of the fly may be due to bacterial agency. Only very transient swelling and irritation are, however, normally caused by the bite of *G. morsitans*, so that it is probable that the more severe reaction occurring in persons subsequently found to be infected, is due to the introduction of the virus of trypanosomiasis. The site of the inflammation, in all cases on the back of the neck, is explained by the fact that this is the usual part attacked by the fly when the subject is clothed. Unclothed natives, on the other hand, are usually attacked on the back or shoulders, and any local reaction would be considered as an ordinary boil and so disregarded and forgotten.

The local symptoms above described are accompanied by a general *malaise*, probably associated with a rising temperature. The acute manifestations are heralded by a sharp attack of pyrexia, sometimes accompanied by rigor, and the usual concomitants—headache, pains in the back and limbs, and nausea. The patient is only semi-conscious and there may be delirium. Diarrhœa occurs in some cases, but in others there is obstinate constipation. The temperature at first shews only slight remissions, and ranges from 103° to 104·5°. In one (untreated) case, Dr. G., the temperature became more irregular from the fifth day,

and soon showed intermissions. Œdema of the feet and legs developed on the twentieth day and "considerable deep-seated pain was complained of . . . there was much pain on micturition, and twitching of the fingers during sleep. . . . Latterly some diminution of sensation in the extremities was complained of."[9] Unfortunately the patient at this stage developed pneumonia, which proved fatal.

In the case of Mr. R. the temperature was 102·5° on the seventh day after infection and rose gradually during the following week (to 104·2°). The patient was seen on the tenth day after the onset of the pyrexia; he was then "only semi-conscious; breathing stertorous. The neck was acutely inflamed, tender and indurated; glands not palpable. Tonsils and fauces swollen and inflamed, and covered with sloughy mucus. Pulse 120, regular, but feeble and of low-tension. Temperature, a.m., 102°. Parasites very numerous (10 in one field). Atoxyl, grs. VI., injected. During the day the temperature rose steadily, reaching 105° at 6 p.m. At midnight the patient was greatly distressed, and the temperature is said to have been over 108° in the axilla. Shortly afterwards profuse sweating set in and the temperature fell to normal." When seen the next day the patient was very weak but conscious. The temperature was 99°. Parasites were still present in the peripheral blood, but the numbers were greatly diminished. The injection of atoxyl was repeated. The following day no parasites were found in two slides, and they remained absent for five days. Thereafter they reappeared and were constantly present, though in varying numbers, throughout the course of the disease. On the thirteenth day the improvement was very marked, the patient being cheerful and all objective symptoms having cleared up.

The above notes, made at the time by the writer, are reproduced as illustrating the severity of the infection, and the exceptionally sharp reaction to atoxyl.

A history of recurring attacks of headache and pain in back and limbs ("litsipa") is frequently obtained from native cases, and it is probable that the onset of the disease is characterised by an initial pyrexial attack of more or less severity in all cases. Many native patients mention œdema of the feet as the earliest symptom, and this was seen in one. Allusion has already been made to the occurrence of œdema in the European case, Dr. G., on the twentieth day of the disease.

It is a very constant symptom later, but it would seem that it not uncommonl yrecurs from time to time throughout the course of the disease.

(2). Following the initial fever there is a stage of periodical attacks of fever, which recur in some cases with marked regularity; a corresponding increase in the number of parasites has been observed, though no exact enumerative methods have been attempted. This recurring fever is associated with a certain amount of emaciation and weakness, but frequently the condition of the patient improves under treatment. Severe pain in the legs is an almost constant complaint, and often seems to cause the patient more distress than any other symptom; the pain is often said to be worse at night.

In the European case, Mr. R., the periodicity of the fever was very marked. At first there was a 3 days' period of pyrexia followed by 4 days more or less complete intermission; later, in the third month, the apyrexial period extended to 5 days, and the 3 days' rise in temperature was less.

This stage may continue for some months under treatment; the patient is sometimes able to work, the appetite is good, and there are frequently no objective symptoms. Sooner or later, however, the patient begins to lose strength, emaciation rapidly increases, and there is marked anæmia. The temperature becomes remittent and the periodicity is lost; later it is very irregular, though it does not range high, rarely above 101°—in some cases it does not exceed 100°. After a few days the patient becomes too weak to walk and does not leave his bed; he loses interest in his surroundings, and refuses any but the most easily swallowed food. Obstinate diarrhœa frequently sets in and helps to undermine the patient's strength. After some two to three weeks the weakness and emaciation are extreme, the patient becomes unconscious and cannot be roused. Food is no longer taken. Occasionally there is muttering delirium, but more often the patient is completely comatose. In from two to three days the patient is dead. In some cases there is a rise of temperature (103°) immediately before death, but there is never hyperpyrexia. In one such case the patient was working (voluntarily) up to within a month of death, and, though somewhat thin, he had no objective symptoms. Parasites were, however, always plentiful in the blood. In this case, as in many others, no trypanosomes could be found in the blood when the coma preceding death had set in.

In other cases, usually those that have been diagnosed early and have been under treatment for some months, the symptoms of the last stage are similar to the above, but the course is longer. Even in these there is an absence of the clinical picture of sleeping sickness. The symptoms suggested rather a toxœmia. Often, though apparently asleep, he is conscious of one's entrance into the hut and opens his eyes directly when spoken to, and looks at his interrogator when replying. His manner, however, is frequently dull and apathetic, and cerebration is slow. He will not fall asleep during one's visit. He will take his food normally except when prevented from doing so by weakness.

In such cases the emaciation becomes so extreme that it is impossible to prevent the formation of bedsores. A few days before the end the lips become swollen and ulcerated; incontinence occasionally occurs, but it is not common. The onset of coma is invariably of fatal significance, and death ensues in from two to three days.

(3) *Glands.**—Of the 47 cases diagnosed, 12 died before admission and were not seen. In the other cases the posterior cervical glands were affected at some period during the time that they were under observation, as follows:—

Of 35 cases	4 or 11·4	per cent.	had glands	classed as	+.
	7 ,, 20·0	,,	,,	,,	+. -.
	10 ,, 28·5	,,	,,	,,	+ - -.
	14 ,, 40·0	,,	no palpable glands.		

Of the 4 cases having + glands, one was a European and 3 were natives. In the first, Mr. R., the adenitis developed in the fifth week, both sides being simultaneously affected. The enlargement was transitory, but recurred several times during the following three weeks. A month after the initial attack no trace of enlargement remained, and there was no further recurrence. In the second case the patient dated his illness from the commencement of pain in the neck, four days before he was seen; in this case also the adenitis was bilateral. It was very transient and did not recur; subsequently only one gland, classed as + -, remained enlarged. The other two instances have occurred recently; in both cases several glands were enlarged.

* The following classification for degree of enlargement is used as being sufficiently exact for practical purposes:—

+ - - = Small shotty glands; unpuncturable.
+ - = Not immediately evident, but puncturable.
+ = Obviously enlarged and easily puncturable.

In view of the transitory nature of the enlargement, it is evident that under different circumstances at least one of these cases might have been classed as having + - enlargement, and another as having no palpable glands. *Per contra*, it is probable that at least some of the other cases would have been found to have + glands if they had been seen earlier. This symptom is, however, usually noticed by natives, so that a history thereof should be obtainable. No history, either of pain in the neck or of a "lump" has been elicited from patients or their relatives.

With regard to + - glands, it will be seen that for every patient having this degree of enlargement, there were two who had no palpable glands. In healthy natives above the age of six years, 6·4 per cent. were found to have + - glands without obvious cause. Since ·3 per cent. of the population was found to be infected, 6·4 per cent. had + - glands, and 20 per cent. of those infected had similar enlargement, then only ·93 per cent. of natives having + - glands were found to be infected.

It should be noted that no difference has been detected between the + - glands of infected persons and those of healthy natives. The glands are usually single, freely movable, and, though not hard, are firm and not of the typical consistency of those classed as +. A chain of such glands was noted in one patient.

It is of interest to note that one man who was found to have a + - gland in September, 1910, which was punctured, the blood also being examined, both with negative results, was found to be infected in September, 1911. He was a mission teacher, and had been working up to within four months of his death at the end of September. As no other similar case has been met with this was probably merely coincidence, and I do not consider that the earlier enlargement was due to trypanosomiasis.

Enlargement of the posterior cervical glands was noted in three of the earlier cases, but I do not know how they were classified.

With regard to glands other than those of the posterior cervical group, no degree of enlargement greater than + - - has been noted in any native without obvious cause. The inguinal glands are almost invariably enlarged in all natives.

(4) *Skin.*—A circinate erythema occurred in the eleventh week in one case, Mr. R.; the back and chest were affected. The rash cleared up in three days, and reappeared for a similar period some two weeks later.

In one of the earlier cases a "papular rash" is recorded. A history of a rash "like measles" was obtained in two of my cases. It was regarded by the patients as the initial symptom. With the exception of such conditions as pityriasis versicolor, common in all natives, no rashes have been seen in native cases.

The skin becomes very coarse, dry and scaly in many patients, but this is also seen in other conditions, especially in old people.

Œdema of the extremities is invariably present at some time during the course of the disease. The feet and anterior tibial regions are most commonly affected, but it also occurs in the hands, and, less often, in the face. As already mentioned, the œdema may occur soon after infection, and the degree varies considerably from time to time in individual cases. As a late symptom it is nearly constant. Some patients complain of severe pain in the feet, especially at night, preceding the development of the œdema; they sometimes state that the pain is markedly less as soon as the feet swell.

(5) *Nervous System.*—Tremor of the tongue and hands occurs in all cases in the last stages. In one case coarse tremors of the limbs, almost amounting to clonic spasm, were observed.

Epileptiform seizure was seen in one case. The patient was one of the few diagnosed early, and showed no objective symptoms. He had been treated with atoxyl, grs. VI., two days with 12 days' interval. No parasites were found after the commencement of treatment. Two months after admission, and five days after an injection of atoxyl, the temperature, which had been normal throughout, was found to be 99·40°, and the following day he had a "fit," resulting in paraplegia, accompanied by a temperature of 101°. The next day there was a second, slighter attack, epileptiform in character, during which he was unconscious for some five minutes; in the evening the temperature was sub-normal. He was quiet during the night, but died at dawn. The paraplegia persisted to the end. There was no family history of epilepsy.

Delirium, usually of a muttering type, occurs in some of the more rapid cases. In one case only did the patient become violent; the delirium was delusionary. The patient died on the third day.

No ocular symptoms, unconnected with treatment, have been noted.

Otitis media occurred in four cases. Deafness resulted in two of these, and also was noticed in two other cases in the later stages.

Loss of power in the legs is usual in the last stage, and seems to be the primary cause of the patient becoming bed-ridden. In one instance the onset was sudden, and was accompanied by coarse tremors affecting the whole body.

Taking into consideration the pain in the legs already alluded to, I am inclined to regard this symptom as being due to a multiple neuritis.

(6) *Circulatory System.*—Mitral insufficiency has been noted in six cases out of 32 admitted to the camp, — 18·7 per cent. In one very advanced case the heart was dilated and the rhythm irregular; in the others compensation was maintained.

(7) *Respiratory System.*—Slight bronchitis has been observed in about a third of all cases, and pleurisy in two. These conditions are common among natives. A large proportion of advanced cases admitted give a history of "chifua," a term which includes any condition causing cough. I am not inclined to attach much importance to this.

I have not seen any of the fits of coughing with respiratory difficulty, reported by THIROUX,[10] as occurring in sleeping sickness.

(8) *Digestive System.*—A form of dysenteric diarrhœa has frequently attacked the patients in both the Mvera and the Ng'ani camps; it yielded readily to treatment in most cases, but was the immediate cause of death in some old patients. It should be mentioned that a similar affection is very common among the natives, especially at certain times of the year.

The spleen has been found to be enlarged in a number of the patients. It is difficult to say what the significance of such enlargement may be.

No marked enlargement of the liver has been noted.

VIII.—TREATMENT.

(1) *Dioxydiamidoarsenobenzol ("Salvarsan.")*—This preparation has been tried in five cases; a single injection was given to each case, intramuscularly. One patient was given ·4 grm., two ·5 grm. and two ·6 grm. A neutral suspension of the drug with NaHO in distilled water was used, half being injected into each buttock. Some difficulty was experienced owing to the needle becoming blocked, as the only one available had too fine a bore. Especially was this the case when the injection was interrupted from any cause—such as movement of the patient. Very careful clearing of the bore of the needle was necessary after each injection.

Local pain, in some instances referred to the feet, was complained of by all the subjects, but in no case did it seem severe. Some deep-seated brawny infiltration resulted at the site of injection in two cases, one of whom had ·4 grm. and the other ·6 grm. There was no evidence of abscess.

Of these five cases, one died 14 days, and another 21 days after injection; all were dead within two months. Not one showed even temporary improvement. In two instances no parasites were found after injection, but they had always been scarce in one, and the patient was the first to succumb; in the other the disappearance was only temporary (5 days) and was possibly only coincidence.

It should be added that all these cases were advanced, and were considered as hopeless. Possibly the drug may be more successful in more favourable subjects.

(2) *Atoxyl.*—This drug has not been tried in combination with others, except with hyd. perchlor., but its use singly has been discontinued owing to the onset of amblyopia in several of the cases, when continued for any length of time. Attempts were made to obviate this by discontinuing the drug for a time and resuming after an interval. One case relapsed soon after the injections were stopped, and died, further treatment being refused. Another complained of dimness of vision when a single dose, ·6 grm., had been given after an interval of two months.

The methods of administration tried are as follows:—

(1) Atoxyl, ·4 grm. or soamin, grs. X. every 13th and 14th days.
(2) Same as (1) plus hyd. perchlor. gr. $\frac{1}{3}$ on 7th day.
(3) Atoxyl, ·6 grm. once a week.
(4) Soamin, grs. XV. every 14th day.

Of these methods, No. 1 was the most successful in prolonging life; two cases survived more than ten months after admission, and one eight months, but all three became partially blind. Two others showed temporary improvement, one of them at the expense of the sight.

There seems to be little to choose between the other methods tried. In many instances treatment had perforce to be discontinued, owing to the dislike of the patients to the intramuscular injection.

(3) *Soamin.*—This was not found to have any advantage over atoxyl, with which it was interchanged in most cases. In the one case in which

it was persisted in alone, the eyes were not affected; seven doses of 15 grs. were given. The patient improved considerably for some two months, but relapsed and died. The parasites persisted throughout.

Reference to Table I. will show that:—

In class A there have been three apparent recoveries—two of them without treatment, the diagnosis not having been confirmed—and two deaths.

In class B several patients have been benefited temporarily by treatment, but there was no lasting improvement in any—all relapsed and were dead within a year.

In class C not one case was benefited in the slightest degree by any form of treatment.

IX.—DIAGNOSIS.

It will be seen from the symptoms above described that this form of trypanosomiasis, broadly speaking, differs from that transmitted by *G. palpalis* only in severity and rapidity of course, due to the virulence of the strain. It is, however, just these characteristics which make the diagnosis difficult. In individual cases repeated blood examinations, inoculation of susceptible animals, etc., may be employed, but in dealing with large numbers of natives inhabiting an infected area, these can only be used to confirm or disprove a tentative diagnosis from physical signs. The course of this disease is so rapid, and the physical signs are so fleeting and irregular in the early stages, that as a rule there are no indications by means of which subjects may be chosen for the more exact methods of diagnosis, until the emaciation and weakness of the last stages have developed.

The gland palpation method has been tried from time to time, but no cases have been found by this means. In one instance a village was visited and all the inhabitants palpated for enlarged cervical glands. A month later two of them were found to be infected, one being classified as B, and the other C. There was no doubt that both had been seen on the first visit.

It was hoped that auto-agglutination would be of use as a means of diagnosis, but though the blood shows this phenomenon in the majority of infected persons, it varies considerably in degree, and has been altogether absent in one or two cases. On the other hand it has been

observed in persons in whom repeated examinations have failed to find trypanosomes, and who have subsequently shown no signs of illness.

Marked leucocytosis occurs in most cases, the large mononuclear elements being chiefly affected, but as a rule it is not in any way marked till death is imminent.

X.—MORBID ANATOMY.

One of the earlier cases (No. 9) died in Zomba and a post-mortem examination was made by Dr. STANNUS, but revealed little.[11] No autopsy has been performed at the camp in deference to native superstitions, as it was feared to make segregation even more dreaded.

REFERENCES.

1. Nyasaland Sleeping Sickness Diary. Part X. p. 7.
2. Zeitschrift für Hygiene und Infectionskrankgeiten. 1911, Oktober. lxix. Heft 3. pp. 553–558.
3. S.S. Bureau. Bulletin No. 31. Vol. 3. p. 391.
4. Proceedings of the Royal Society. 1911. August 18. B. 570. pp. 156–160.
5. Nyasaland Sleeping Sickness Diary. Part XIII. pp. 10–14 (from notes by Mr. JOLLYMAN, N.E. Rhodesia.)
6. *Ibid.*
7. *Ibid.*
8. *Ibid.*
9. *Ibid.*
10. La maladie du sommeil et les Trypanosomiasis animales au Senegal. 1911. Paris Lib. Baillière et fils.
11. Nyasaland Sleeping Sickness Diary. Part XII. p. 5.

TABLE I.

TREATMENT.

No. of Case.	Date of Admission.	Stage of Disease.*	Method of Treatment.**	Date of Death.	Remarks.
11	8/8/10	C	Nil.	14/9/10	
12	31/8/10	B	(see note***).	5/6/11	Returned to S. Africa, Jan.'11.
13	5/9/10	C	Nil.	8/9/10	
14	10/9/10	C	1.	28/10/10	No improvement.
16	13/10/10	C	Nil.	13/10/10	
18	16/10/10	A	1.	—	No symptoms after 2½ months' treatment. Treatment continued 6 months. No relapse.
19	16/10/10	C	1.	28/10/10	No improvement.
20	13/10/10	B	1 (6 months).	8/8/11	Amblyopia. Salvarsan given 25/7/11.
21	15/11/10	B	2, 3.	1/4/11	Temporary improvement for 3 months.
23	3/12/10	B	1 (5 months).	20/7/11	Partially blind.
24	23/12/10	B	1 (5 months).	8/10/11	·6 grm. caused partial blindness after 2 months' interval.
25	8/1/11	A	1.	8/3/11	Epileptiform attack, paraplegia.
27	7/3/11	C	1.	30/3/11	No improvement.
31	9/3/11	B	1, 3.	19/6/11	Partially blind.
32	9/3/11	B	1.	2/4/11	Dysentery.
34	14/3/11	C	1.	8/4/11	No improvement. Dysentery.
35	10/3/11	C	Nil.	14/3/11	
36	17/3/11	C	Nil.	19/3/11	
37	23/3/11	B	3 (2 months), 4 (2 months), 5.	12/9/11	Great improvement, lasting 4½ months. Relapse.
38	29/3/11	B	1 (3 months), inter. (4 months), 4.	17/11/11	Apparent recovery, 4 months. Tryps. returned. Relapse.
39	4/4/11	B	"Maningo" (1 month).	27/6/11	Rapid course.
40	1/4/11	B	Ditto, 2, 5.	1/10/11	No improvement at first. Improvement with (2). Relapse.

TABLE I.—TREATMENT—continued.

No. of Case.	Date of Admission.	Stage of Disease.*	Method of Treatment.**	Date of Death.	Remarks.
44	8/5/11	A	Nil.	—	Diagnosis unconfirmed.
46	25/5/11	—	Nil.	—	Ditto.
49	28/5/11	B	4.	30/10/11	Temporary improvement. Relapse.
51	28/6/11	C	Nil.	16/8/11	Dysentery.
52	9/7/11	C	5.	20/8/11	No improvement.
53	18/7/11	C	Nil.	20/7/11	
57	13/10/11	C	Nil.	6/11/11	
58	5/12/11	B	Nil.	15/1/12	
60	9/12/11	C	Nil.	14/12/11	
61	16/12/11	C	Nil.	13/1/12	
62	28/12/11	C	Nil.	—	

*NOTE.—A = "cas en bon etat"; B = clinical signs present; C = advanced case.

**METHODS OF TREATMENT:—1. Atoxyl ·4 grm., or soamin grs. X, every 13th and 14th day.

2. Same as 1, plus hyd. perchlor. grn. 1/3, on 7th day.

3. Atoxyl, ·6 grm. once a week, or soamin grs. X.

4. Soamin grs. XV. every 14th day.

5. Salvarsan.

***CASE NO. 12.—First 5 weeks, atoxyl grs. 6, 2 successive days, 5 days' interval.

Second 5 weeks, atoxyl grs. 3, every 3rd and 4th day.

11th to 18th week, soamin grs. X., every 13th and 14th day, $HgCl_2$ on 7th days.

18th week to discharge, soamin grs. X., 2 successive days, interval of 5 days.

CASE NO. 22, though under treatment for a short time, is not included in the above table, as there is some doubt as to the diagnosis.

TABLE II.

SHEWING RELATION OF TRYPANOSOMIASIS TO G. MORSITANS.

I.—Villages within the Nyansato fly-belt, removed in 1910 to hills: 6 cases. All reported a heavy death-rate.

II.—Villages situated on the border of the Nyansato fly-belt, having gardens within it.

	No. of Villages.	Population (over 6 years).	Deaths from all causes, 1911.	Per cent.	Cases of Trypo., 1911.	Per cent.
Villages in which cases of Tryp. have been found, 1910-12 ...	5	M. 202 F. 225 427	M. 29 F. 20 49	M. 14·3 F. 8·8 11·4	M. 11 F. 3 14	M. 5·4 F. 1·3 3·2
Villages in which NO cases of Tryp. have been found, 1910-12	—	—	—	—	—	—
TOTALS ...	5	427	49	or 11·4	14	or 3·2

III.—Villages on the plains, in the vicinity of the fly.

Villages in which cases of Tryp. have been found, 1910-12	15	M. 691 F. 780 1471	M. 23 F. 25 48	M. 3·3 F. 3·2 3·2	M. 8 F. 7 15	M. 1·15 F. 0·8 0·97
Villages in which NO cases of Tryp. have been found, 1910-12	40	M. 1189 F. 1900 3089	M. 33 F. 46 79	M. 2·7 F. 2·4 2·5	— — —	— — —
TOTALS ...		M. 1880 F. 2680	M. 56 F. 71	M. 2·9 F. 2·6	M. 8 F. 7	M. 0·47 F. 0·2
	55	4560	127	or 2·7	15	or 0·31

TABLE II.—SHEWING RELATION OF TRYPANOSOMIASIS TO G. MORSITANS—continued.

IV.—Villages in the foot-hills, little exposed to fly.

	No. of Villages.	Population (over 6 years).	Deaths from all causes, 1911.	Per cent.	Cases of Trypo., 1911.	Per cent.
Villages in which cases of Tryp. have been found, 1910-12	3	M. 188 F. 273 461	M. 8 F. 8 16	M. 4·2 F. 2·9 3·5	M. 1 F. 1 2	M. 0·53 F. 0·36 0·44
Villages in which NO cases of Tryp. have been found, 1910-12	63	M. 1634 F. 2462 4096	M. 25 F. 24 49	M. 1·5 F. 0·9 1·2	— — —	— — —
TOTALS ...	66	M. 1822 F. 2735 4557	M. 33 F. 32 65	M. 1·8 F. 1·1 or 1·45	M. 1 F. 1 2	M. 0·05 F. 0·04 or 0·04

V.—Villages on the lake-shore, some having gardens in the vicinity of fly.

Villages in which cases of Tryp. have been found, 1910-12	4	M. 134 F. 203 337	M. 8 F. 4 12	M. 5·9 F. 1·9 3·9	M. 2 F. 1 3	M. 1·4 F. 0·49 0·95
Villages in which NO cases of Tryp. have been found, 1910-12	37	M. 2191 F. 3354 5545	M. 37 F. 55 92	M. 1·6 F. 1·6 1·6	— — —	— — —
TOTALS ...	41	M. 2325 F. 3557 5882	M. 45 F. 59 104	M. 1·9 F. 1·6 or 1·7	M. 2 F. 1 3	M. 0·08 F. 0·02 or 0·05

TABLE II.—SHEWING RELATION OF TRYPANOSOMIASIS TO G. MORSITANS—continued.

VI.—All villages in the proclaimed area.

	No. of Villages.	Population (over 6 years).	Deaths from all causes, 1911.	Per cent.	Cases of Trypo., 1911.	Per cent.
Villages in which cases of Tryp. have been found, 1910-12	27	M. 1215 F. 1481 2696	M. 68 F. 57 125	M. 5·5 F. 3·7 4·6	M. 23 F. 12 35	M. 1·8 F. 0·81 1·3
Villages in which NO cases of Tryp. have been found, 1910-12	140	M. 5014 F. 7716 12730	M. 95 F. 125 220	M. 1·8 F. 1·6 1·7	—	—
GRAND TOTAL ...	167	M. 6229 F. 9197 15426	M. 163 F. 182 345	M. 2·6 F. 1·9 or 2·2	M. 23 F. 12 35	M. 0·36 F. 0·12 or 0·24

N.B.—(1) The population is that in January, 1911.

(2) The numbers of deaths, and of cases of Trypanosomiasis, are those which have occurred during the year 1911 only.

ANALYSIS OF TABLE.

(1). The percentage of deaths from trypanosomiasis varies in direct proportion to the distance from the fly.

(2). The percentage of deaths from all causes has a similar variation, but is greater than can be accounted for by the number of cases of trypanosomiasis actually diagnosed.

(3). The number of males diagnosed as infected is nearly twice that of females.

DEDUCTIONS.

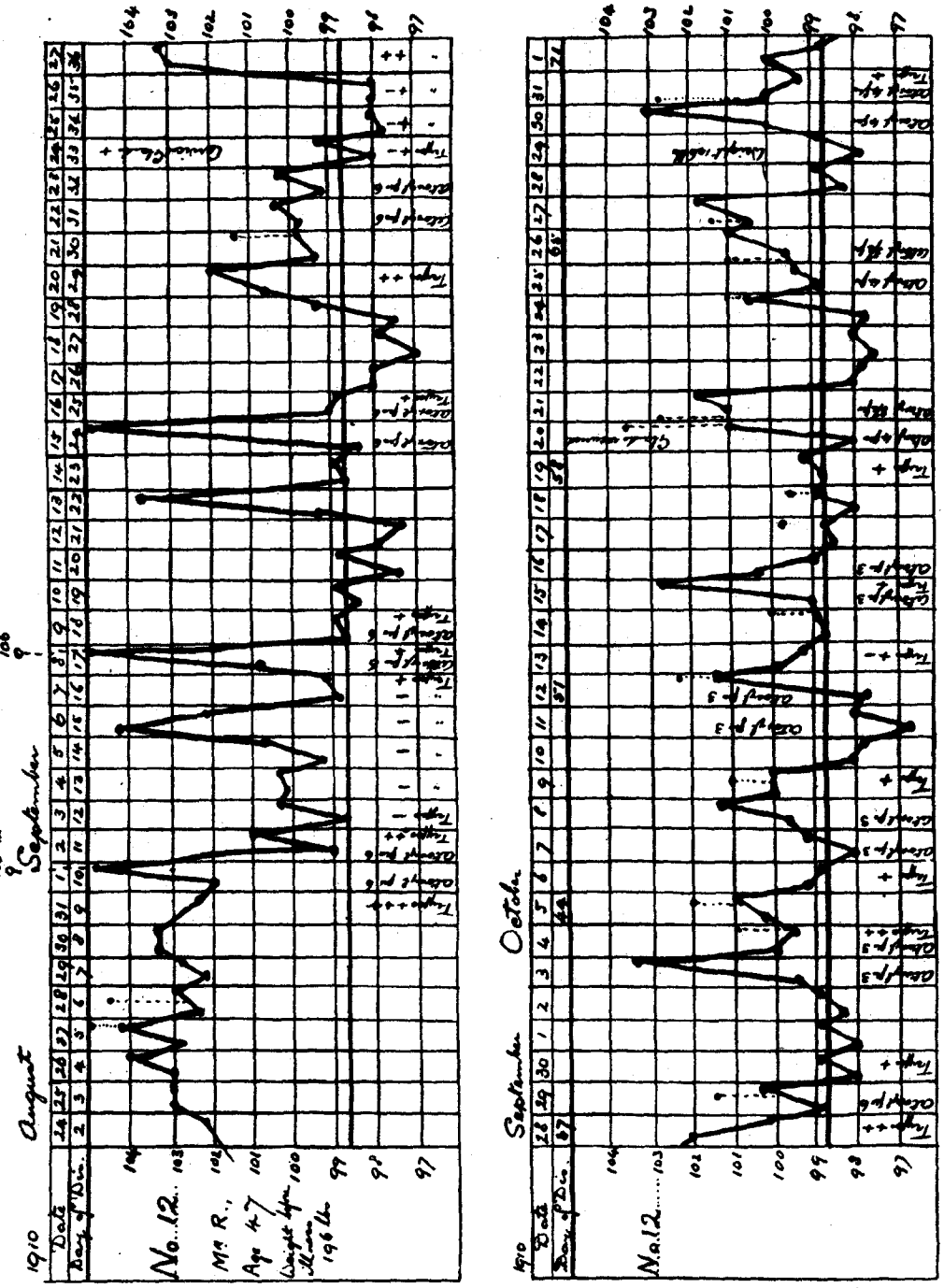
(1.) That *G. morsitans* is a definite host for this form of trypanosomiasis, and in this district, at least, is that most concerned in the spread of the disease.

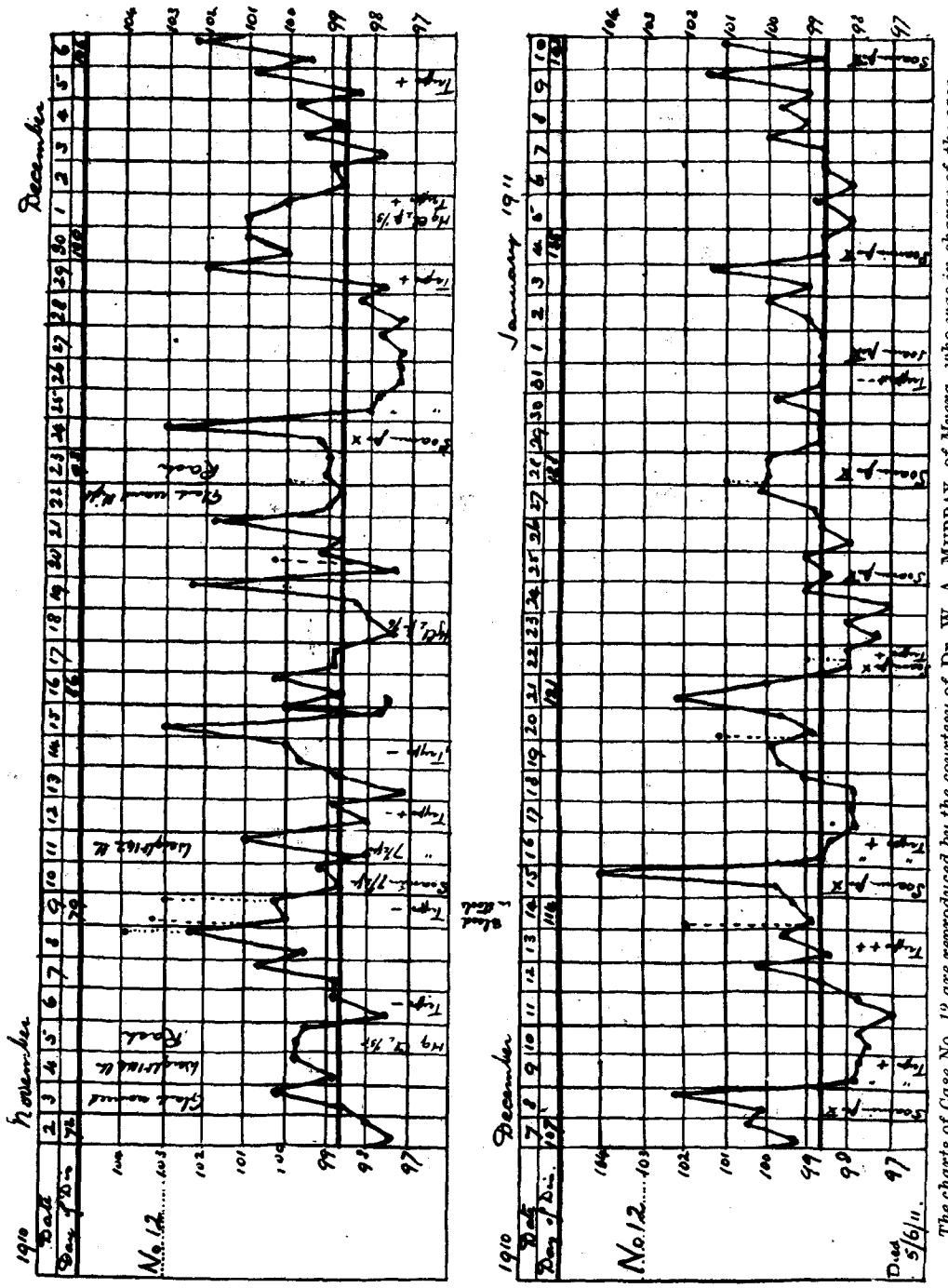
(2). That a larger number of persons are infected with, and die of, trypanosomiasis than is represented by the number of those actually diagnosed.

ADDITIONAL REMARKS.

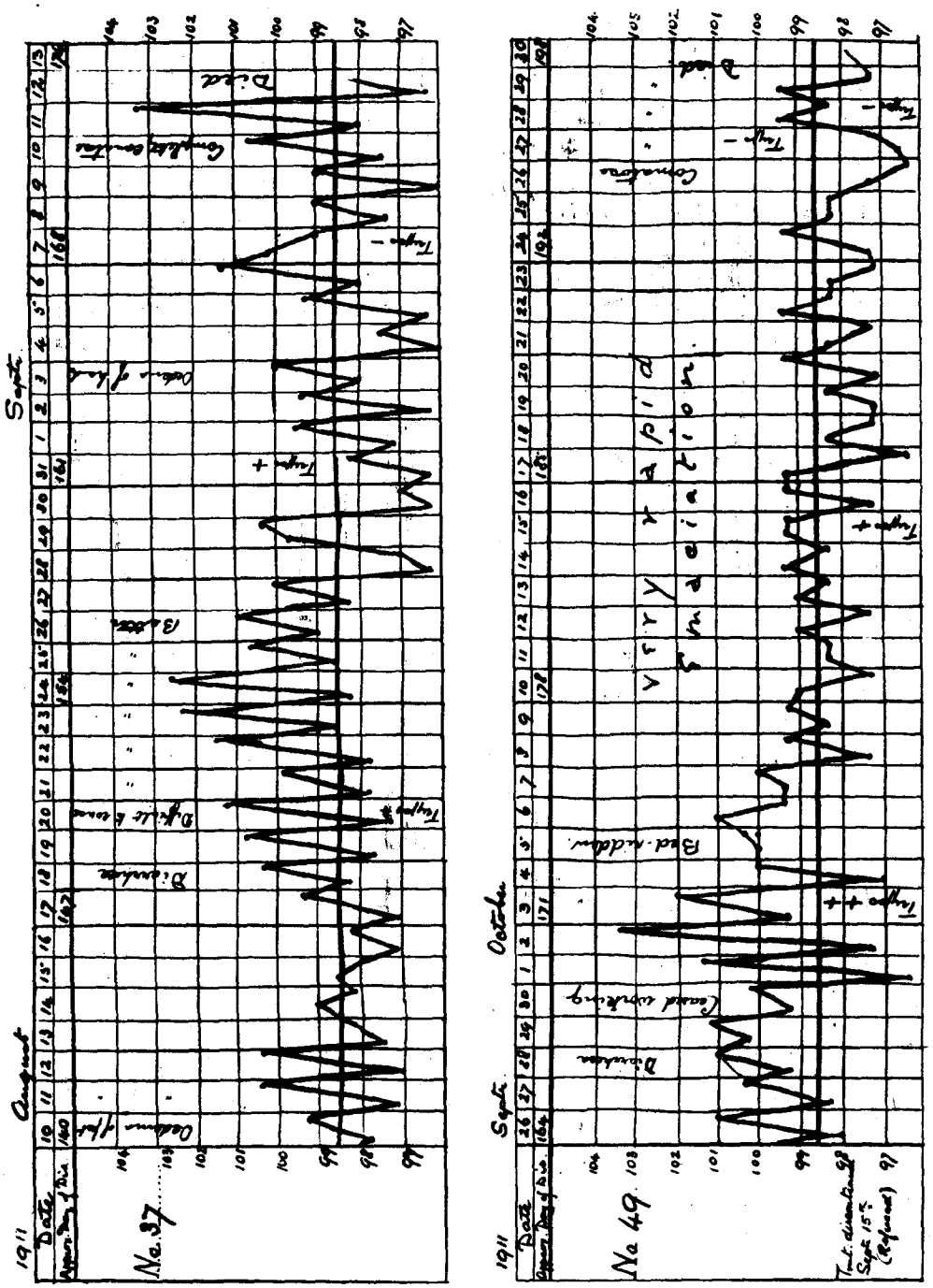
(1). Of the villages situated on the lake shore, those in the Northern part of the proclaimed area have a greater death-rate than those to the south. The same holds good for the villages situated in the foot-hills. This may, possibly, be explained by the fact that the proclaimed area is narrower to the north than to the south, and the fly approaches nearer to the foot-hills and to the lake here than elsewhere, except near Rifu where there are few villages.

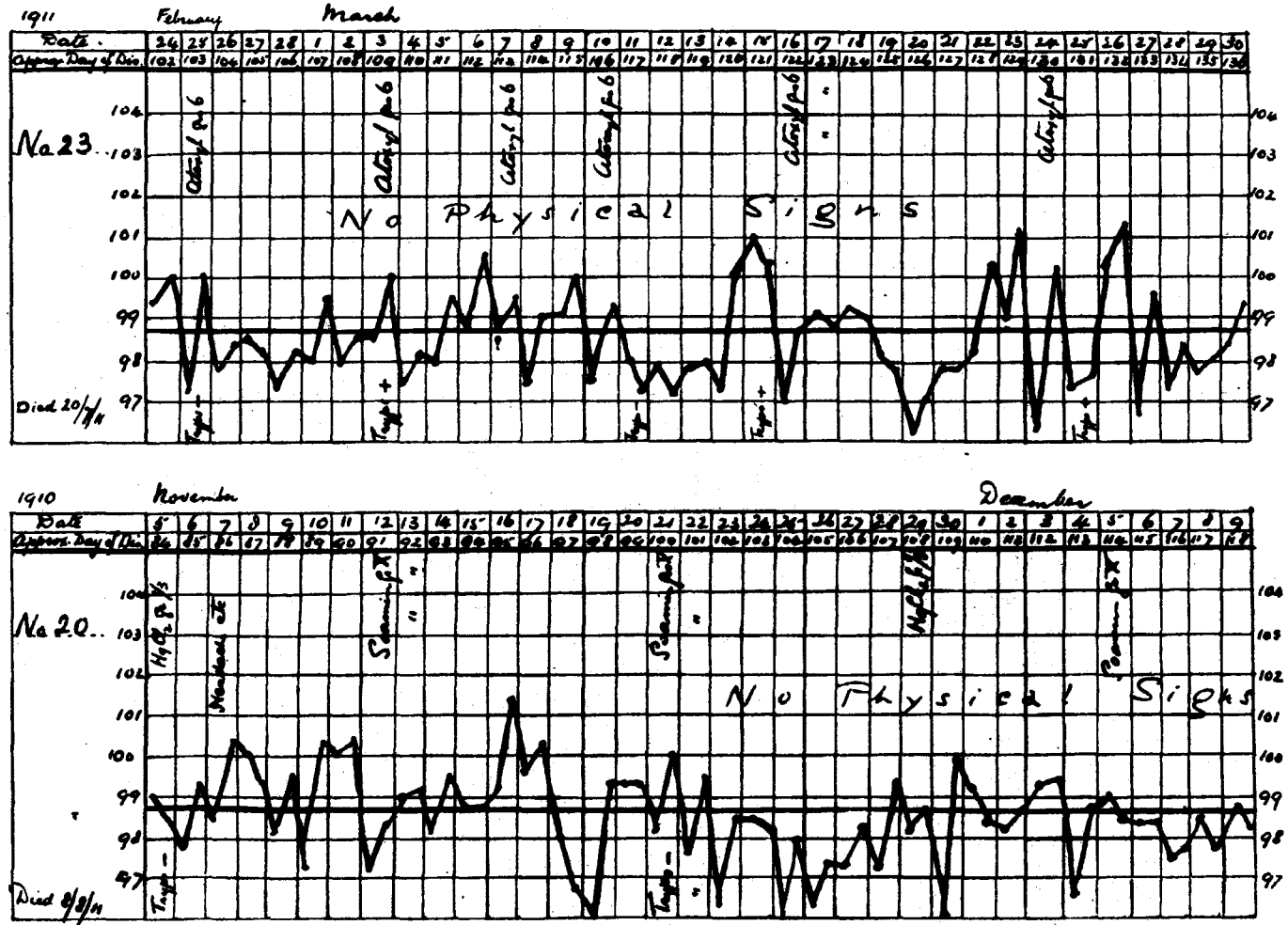
It is of interest to note, in this connection, that *G. brevipalpis* is found only to the north of the area, near the lake shore and up to a distance of about five miles therefrom, on two rivers. This species, however, has not been located in or near the foot-hills


No. 12.
Mr R.,
Age 47
Straight from
Home
1910
August
September
October

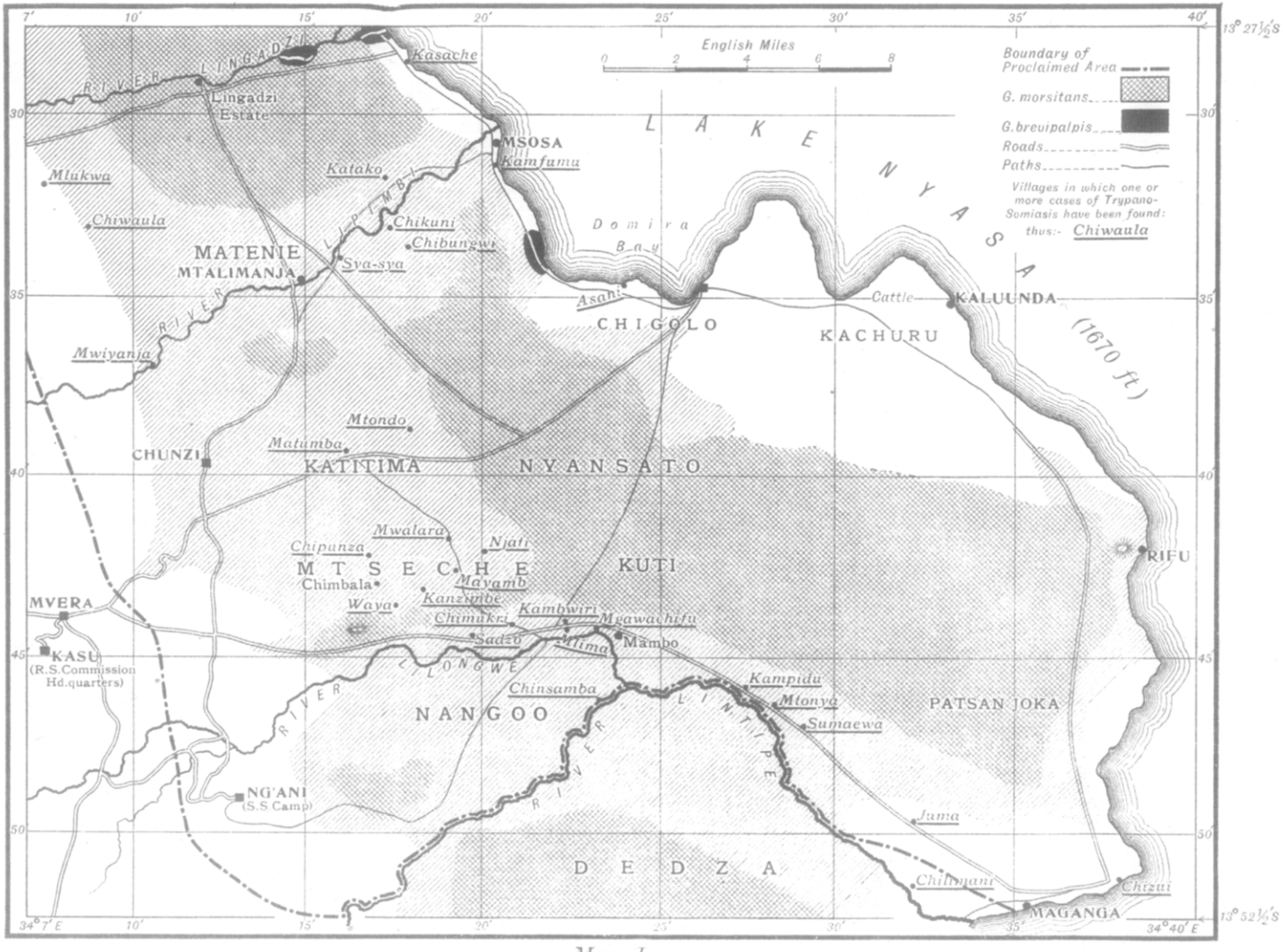


The charts of Case No. 12 are reproduced by the courtesy of Dr. W. A. MURRAY, *of Mvera, who was in charge of the case.*


No. 37
No 49.
Very Malarial
Fever
Glands
Bed-sores
Oedema of face
Convulsions
Death
Tert. diminished Sept 15th (Relapse)

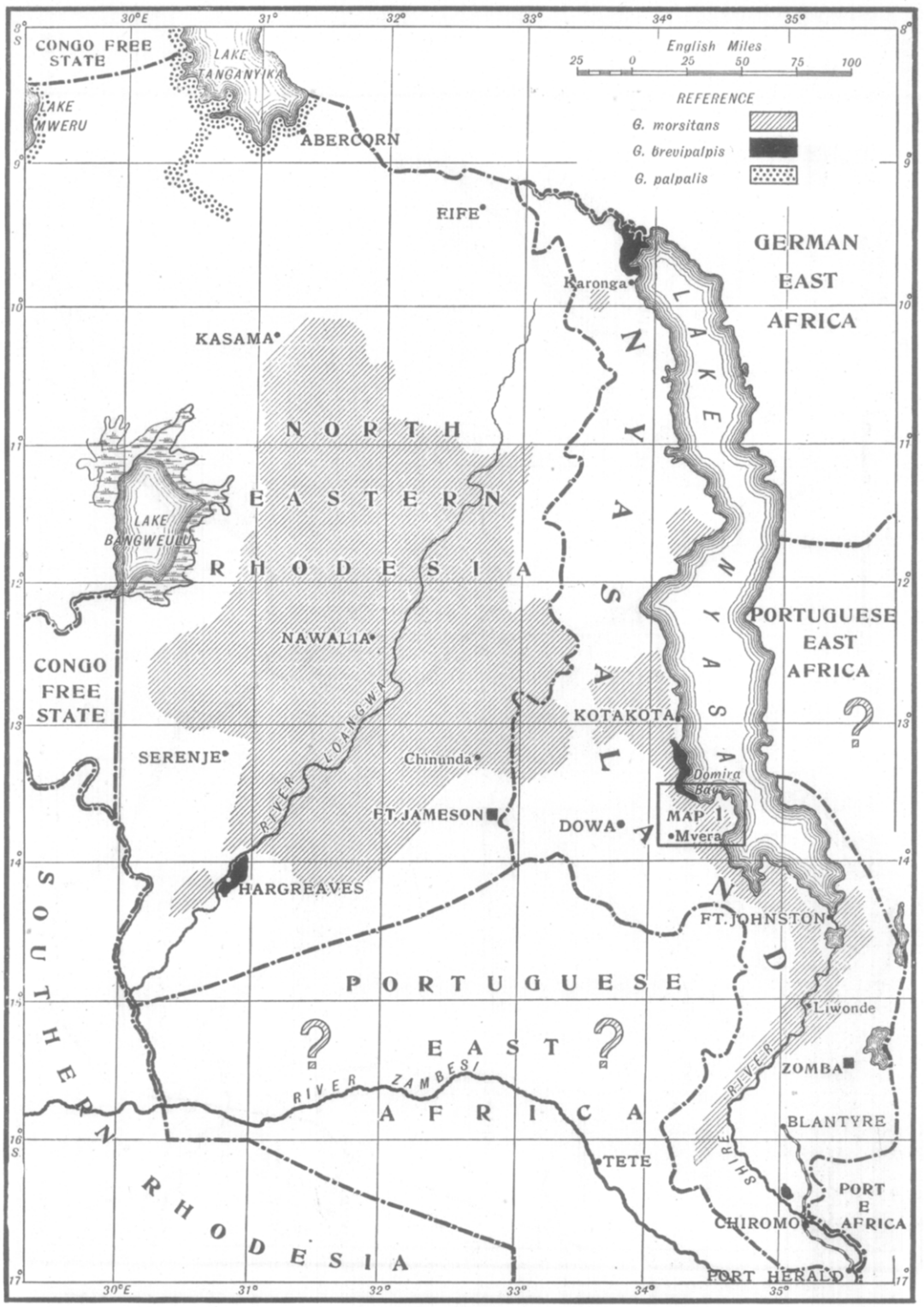

1911
February
March
Date
Approx. Day of Dis.
No 23
No Physical Signs
Died 20/3/11
1910
November
December
No 20
No Physical Signs
Died 8/2/11

Part of the Dowa Sub-District, Nyasaland.



Map 1.

North Eastern Rhodesia and Nyasaland.



Map II.